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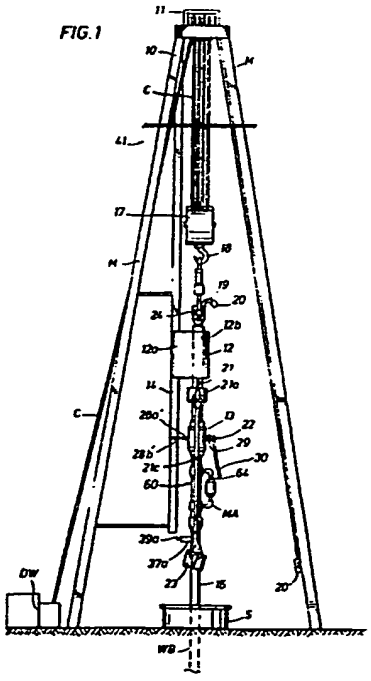
(54) Manifold arrangement for use with a top drive power unit

(57) A manifold arrangement (MA) for use with a top drive power unit (12) enables fluid circulation through the well string (16) for well bore conditioning to be effected with a cementing plug (90) in place in the manifold arrangement and for conducting a pumpable substance such as cement to the well string (16) without first circulating it through the top drive power unit (12). The manifold (MA) includes a first valve 61 which, when closed, supports a cementing plug 90 and a by-pass 64 having a second valve 67. During fluid circulation for well conditioning prior to cementing valve 61 is closed and valve 67 open. During cementing, a swivel feeder 13 is used to feed cement to the string 16, valve 67 is closed and valve 61 opened to release plug 90. A second manifold (MA) may be included if two cementing plugs are to be used.

FIG.1



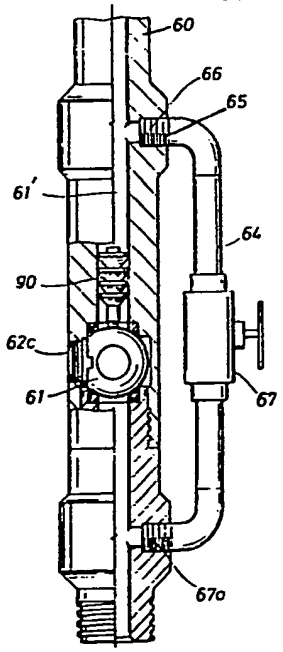


FIG. 4

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FIG.1

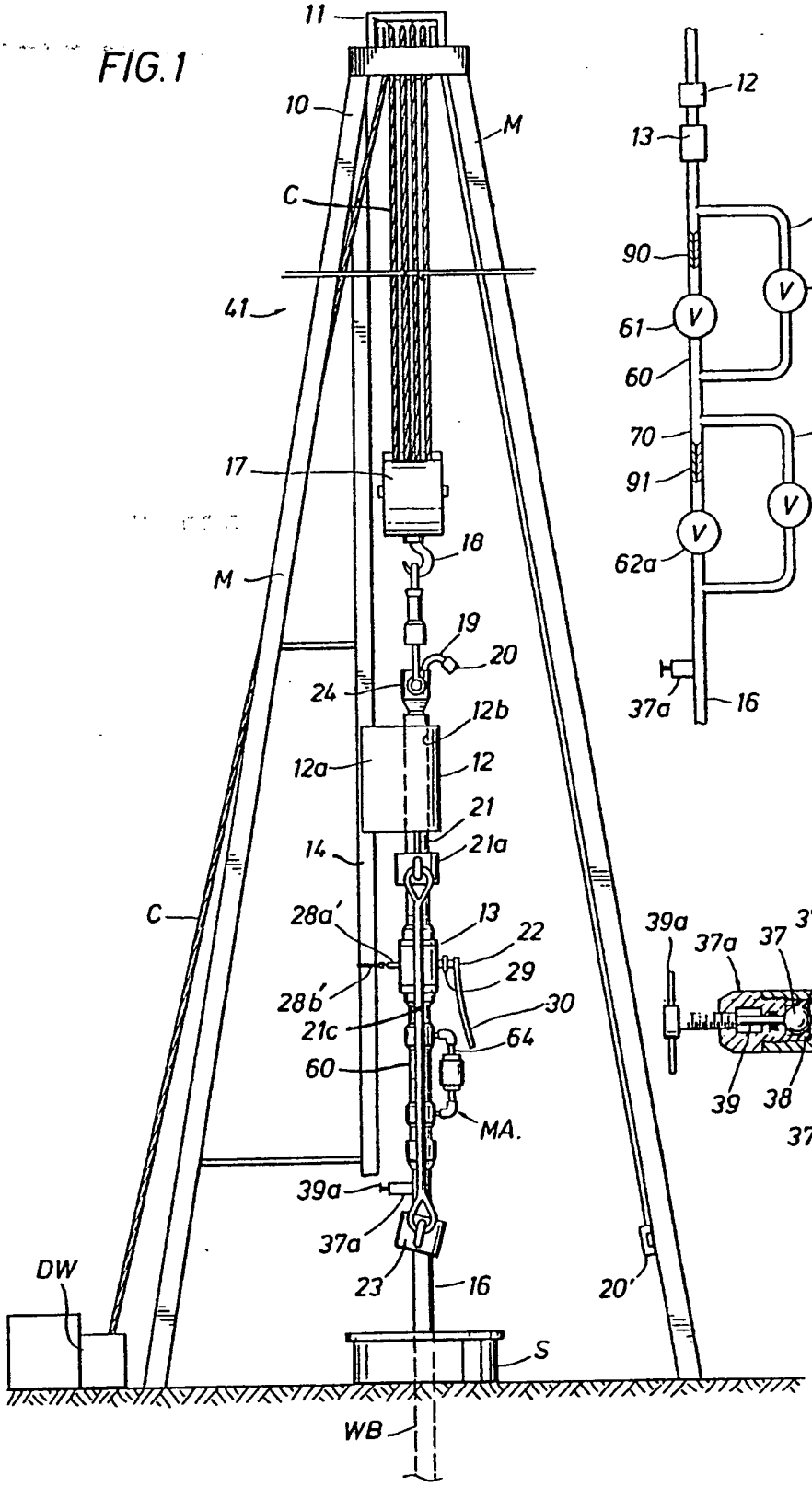


FIG.2

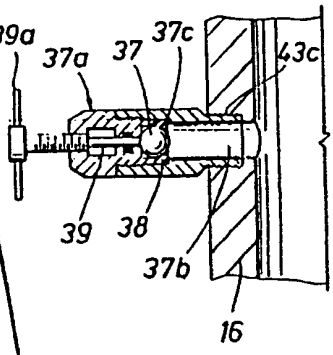
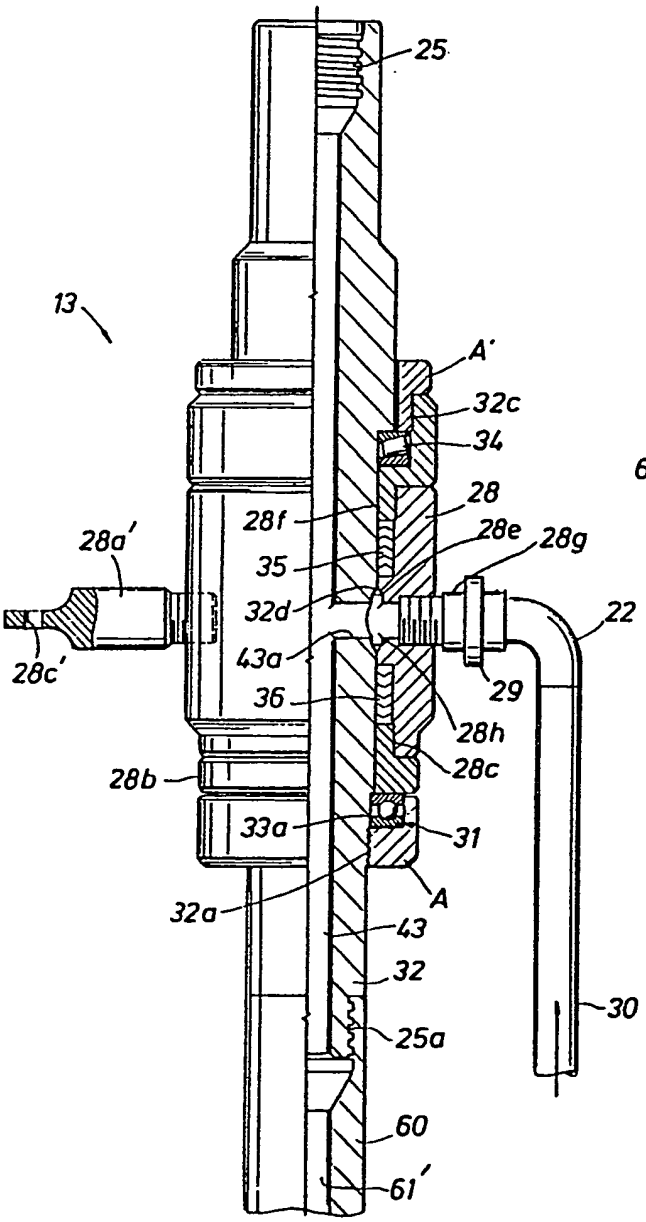


FIG.2A

FIG. 3


25
13
A'
32c
34
28
28f
28e
28g
28a'
35
32d
22
43a
28c'
29
36
28h
28c
28b
33a
31
A
32a
43
32
30
25a
60
61'

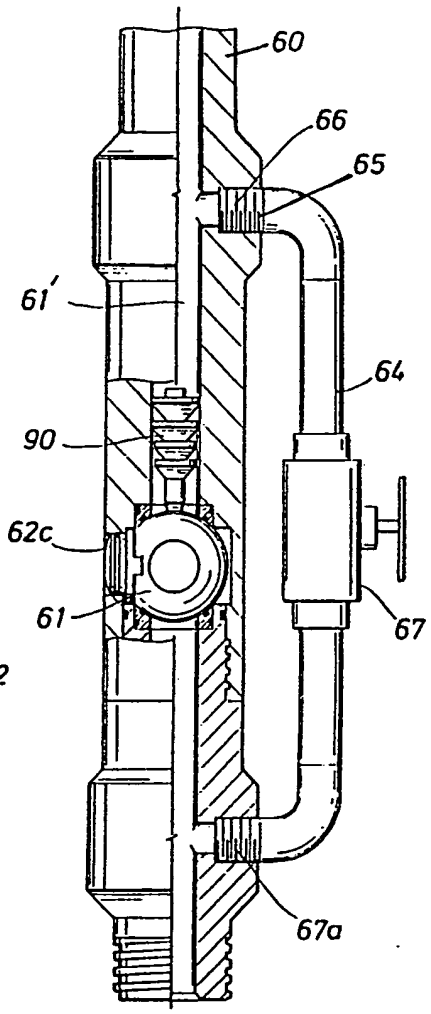

60
66
65
61'
64
90
62c
61
67
67a

FIG. 4

MANIFOLD ARRANGEMENT FOR USE WITH A TOP DRIVE POWER UNIT.

The closest prior art with which applicant is familiar is United States Patent No. 4,722,389 issued to applicant of the present invention and United States Letters Patent No.3,828,852 issued on August 13, 1974.

U.S. Patent 4,722,389 discloses an arrangement for connecting with the rotatable hollow stem of a top drive power unit so that a pumpable substance such as cement or the like may be conducted to the well string without discharging it through the top drive power unit.

U.S. Patent 3,828,852 discloses a manifold arrangement for discharging cement into the well string while it is simultaneously rotated and reciprocated.

An object of the invention is to provide an improved manifold arrangement for cementing operations.

The invention provides a manifold arrangement for connecting between the hollow, rotatable stem extending through a top drive power unit and a well string for conducting fluid circulation and cementing operations employing cementing pump down plug means comprising:

assembly means for conducting a pumpable substance such as cement to the well string without first conducting it through the top drive power unit rotatable stem, said assembly including:

an outer tubuluar member; a rotatable inner tubular member with a longitudinal passage therethrough;

said rotatable inner tubular member and longitudinal passage therethrough extending through said outer tubular member;

said rotatable inner tubular member having connection means connectable with the hollow stem for communicating the longitudinal passage in said inner tubular member with the hollow stem beneath the top drive power unit and with the well string;

said outer tubular member having lateral flow passage means to communicate with the longitudinal passage extending through said inner tubular member;

said rotatable inner tubular member having a circumferential groove on its outer surface intersecting said lateral flow passage means and said outer tubular member having a mating circumferential groove formed on its inner surface which groove means cooperate to form a continuous fluid flow passage in each said inner and outer tubular members communicating with said lateral passage means;

bearing means to accommodate rotation of said inner tubular member by the top drive power unit relative to said outer tubular member; and

seal means between said rotatable inner tubular member and outer tubular member on each side of said lateral flow passage means;

first upper connection means having a longitudinal passage extending therethrough with an open upper end connected with the top drive power unit rotatable stem for communicating the rotatable stem of the top drive power unit longitudinally into and through said first upper connection means;

first lower connection means having a longitudinal passage extending therethrough with an open upper end connected with the lower end of said first upper connection means;

a valve intersecting the longitudinal passage in said first upper connection means and a valve intersecting the longitudinal passage in said first

lower connection means;

second upper connection means having passage means therethrough connected with said first upper connection means at a point above and below said valve in said first upper connection means for bypassing fluid flow from the top drive power unit around said valve when it is closed with a cement plug means supported therein;

second lower connection means having passage means therethrough connected with said first lower connection means to intersect the longitudinal passage in said first lower connection means at a point above and below said valve in said first lower connection means for bypassing fluid flow from the top drive unit around said first valve when it is closed with a cement plug means supported therein;

a valve in the passage means formed by said second upper connection means which when in open position accommodates fluid flow around said closed valve in said first upper connection means with the cementing plug means supported thereon and when in closed position closes flow through said second upper connection means to thereby direct flow longitudinally into said first upper connection means for propelling the cementing plug means through said open valve in said first upper connection means and into the well string; and

a valve in the passage means formed by said second lower connection means which when in open position accommodates fluid flow around said closed valve in said first lower connection means with the cementing plug means supported thereon and when in closed position closes flow through said second lower connection means to thereby direct flow into said first lower connection means for propelling the cementing

plug means through said open valve in said first lower connection means and into the well string.

The invention will be described further, by way of example, with reference to the accompanying drawings wherein:-

Fig. 1 is an illustration of a mast with a top drive unit mounted therein and one form of the manifold arrangement of the present invention;

Fig. 2 is a schematic illustration of an alternate embodiment of the manifold arrangement;

Fig. 2A is a partial sectional view of a ball support and dropping means;

Fig. 3 is a sectional view of a portion of the manifold arrangement for conducting cement to the well string without first going through the top drive unit; and

Fig. 4 is a sectional view partly in elevation illustrating in greater detail the form of the manifold arrangement shown in Fig. 1.

Attention is first directed to Fig. 1 wherein a mast assembly is referred to generally by the numeral 41 and includes suitable longitudinally extending members M supported on the earth's surface adjacent the well bore WB in the earth's surface. A well string 16 is shown as extending into the well bore, which well string 16 is connected at its upper end to the lower end of a feeder 13 as will be described. The member S at the top of the well bore provides a support for use during "tripping" the pipe, or well string. Schematically illustrated at 11 is a crown block which incudes a plurality of rotatable pulleys. As is well know to those skilled in the art, suitable cable means C extends from a draw works drum DW powered by a draw works which extends up over the pulleys in the crown block 11 and down to what is termed the travelling block 17. The cable C extends back and forth between the pulleys in the crown block 11 and travelling block 17, with one end of the cable secured to a portion of the mast 10 or a suitable anchor represented at 20'.

Laterally spaced, longitudinally extending, preferably vertical, guide rails 14 are supported by the mast 10 and extend longitudinally adjacent the well bore WB which receives the well string 16 as diagramatically represented in Fig. 1. A suitable frame 12a is provided for movement along the spaced guide rails 14, such frame having secured therewith the swivel 24 which is suspended from the hook 18 that in turn is rotatably supported by the travelling block 17. The swivel 24 is provided with a gooseneck 19 for connection with a drilling fluid line 20 whereby drilling fluid may be supplied from an external source to the swivel for discharge through the rotatable stem 12b of the top drive power unit schematically represented at 12 which is supported by the frame 12a for movement along the guide rails 14. A suitable power source, the details of which are not illustrated, are also supported on the frame 12a for imparting rotation to the rotatable tubular member or hollow stem 12b of the top drive power unit, which stem is connected at its upper end with a rotatable tubular member that depends from the swivel 24 and the hollow stem 12b is connected to communicate at its lower end directly to the upper end of the inner member 32 of the feeder 13. The inner member 32 of feeder 13 is connected at its lower end to the manifold arrangement of the present invention desig-

nated generally at MA. The lower end of the manifold arrangement is connected to the upper end of well string 16.

Also suspended from the frame 12a is a pair of diametically opposed support members 21 depending from the power unit 12 and having a generally circular member 21a at their lower end on which are pivotally supported links 21c. The links 21c are pivotally connected at their lower ends with the elevator 23 as illustrated in Fig. 1 of the drawings. The elevator is employed when the well string is being "tripped", that is when it is being lowered into the well bore joint by joint, or removed from the well bore by disconnecting one or more joints at a time from the well string. Otherwise, while conducting normal drilling operations or well servicing operations, the elevator 23 merely hangs alongside the well string 16, as shown so as to not interfere with rotation thereof, or longitudinal movement along with power unit 12. The structure of the power unit 12 and the arrangement of the various components associated therewith are well known to those skilled in the art.

The pumpable substance feeder 13 for conveying pumpable substance such as cement slurry from an external supply source to the top of the well string 16 while bypassing the top drive power unit 12 is shown at 13 in Fig. 1 and in greater detail in Fig. 3. The feeder means 13 includes a inner tubular member or mandrel 32 which extends longitudinally through outer tubular member or housing 28. The mandrel 32 is provided with a longitudinally extending passageway 43 therethrough which communicates with at least one intersecting lateral flow passage means 43a through said inner tubular member intermediate the ends of said longitudinal flow passage. More particularly, the lateral flow passage means 43a is shown in Fig. 3 as being positioned in the inner tubular member intermediate the ends of the outer tubular member 28.

The outer housing 28 is positioned relative to the inner tubular member 32 for sealable and relative rotation therebetween. The positioning means incudes a lower support or cap A which is secured to the inner tubular member 32 by any suitable means such as the threads 32a. A ball bearing arrangement 31 includes the race 33a supported in the cap A to accommodate axial thrust loads encountered by the feed means 13 and is retained by the lower ring 28b supported on the outer housing 28 by any suitable means such as the threads 28c as shown. A

tapered roller bearing race 34 is provided adjacent the other end of the outer housing 28 as shown and is retained in position by means of the upper cap A' engaged with housing 28 by any suitable means such as threads 32c as shown to carry lateral or side thrust loads.

The seal means 35 and 36 between the inner tubular member 32 and the outer housing 28 is positioned so as to be on each side of, or to span the lateral flow passage means 43a. Also, a circumferencial groove as shown at 32d may be formed on the outer periphery or surface of the inner tubular member 32 and a mating groove 28e can be formed on the inner surface of the outer housing 28 to better accommodate continuous fluid flow from an external source of the pumpable substance to the longitudinal passage 43 in the inner tubular member 32. The upper end of ring 28b serves as a retainer for the lower seal means 36 and a suitable retainer ring 28f may be engaged by threads as shown in the outer housing 28 for retaining the seal means 35 in position and to assist in supporting.

It can be appreciated that suitable shoulders are provided in the outer housing 28 on which the seal means 35 and 36 are seated as shown.

An inlet conduit 30 is provided for connection with an external supply source for receiving the pumpable substance therethrough to discharge it through connection 22 and a "WECO" wing fastener 29 which secures the pipe or conduit 30 to the connection 28g that is threadedly secured in the lateral passage 28h of outer member 28 that communicates with groove 28e, groove 32 and the lateral passage means 43a in the inner tubular member.

The feeder means 13 is connected by suitable means such as threaded connection 25 to the lower end of the hollow stem 12b of the top drive power unit 12 whereby rotation and longitudinal movement may be transmitted from the top drive power unit through the feeder means 13 and manifold arrangement MA to the well string 16 connected therewith while the pumpable substance is discharged to the moving well string 16 without first passing the substance through the top drive unit 12.

Suitable threads 25 at the upper end of the longitudinal passage 43 are provided for connection with the lower end of the hollow, rotatable stem 12b of the top drive power unit 12. Thus, the feeder

13 forming part of the manifold arrangement of the present invention communicates longitudinally and directly with the hollow, rotatable stem 12b of the top drive power unit for discharge of well bore circulating fluid through the rotatable unit and the remainder of the manifold arrangement as will be described.

The member 28a' projects laterally from outer housing 28 and suitable means such as a cable 28b' may be inserted in opening 28c' and looped around one of the rails 14 to restrain rotation of housing 28 while accommodating movement along rail 14.

Threaded means 25a are provided adjacent the lower end of the inner tubular member 32 as shown in Fig. 3 for connecting with the upper end of the first connection means 60 of the manifold arrangement MA. The first connection means is in the form of a longitudinally extending conduit with a longitudinal passage 61' extending therethrough as better shown in Fig. 4 of the drawings.

Suitable valve means such as the ball valve 61 is sealably and suitable mounted in the first connection passage means 61' as shown in Fig. 4 for controlling communication through the first connection means 60. When the valve means 61 is in the closed position as shown in Fig. 4, communication through the first connection means is closed off and the first valve means 61 can serve as a support means for the plug means 90 used in cementing operations.

Second connection means 64 are connected with the first connection means as shown in Fig. 4 of the drawings. Such connection means 64 constitutes a conduit with a passageway 65 therethrough. The upper end 66 of the passageway intersects the longitudinal passage 61' of the first connection means 60 above the valve means 61 and the lower end 67a of the passageway intersects the passageway 61' below the valve means 61 as shown.

A suitable valve such as a ball valve 67 is mounted in the conduit of the second connection 64 for controlling communication through passage 65 as will be explained in greater detail.

In Fig. 2 the manifold arrangement of the present invention is shown as including upper and lower first connection means 60 and 70 each having a conduit with longitudinal passage means therethrough and which are threadedly connected together. The well string 16 is in

turn threadedly connected to the lower end of the lower first connection means 70 as schematically illustrated in Fig. 2 of the drawings.

Similarly, Fig. 2 illustrates the alternate manifold arrangement shown therein as including upper and lower longitudinally spaced second connection means 64 and 69. The lower second connection means 69 is similar in construction to the upper second connection means 64 as previously described hereinabove and has its upper end intersecting the longitudinal passage through the lower first connection means above a ball valve 62a arranged in the longitudinal passage of the lower first connection means and the lower end of the lower second connection means intersects the longitudinal passage through the lower first connection means below the ball valve means 62a as shown. The lower second connection means also includes valve means 67 to control flow therethrough.

When the ball valve means 62a of the lower first connection means is closed, a pump down plug means 91 may be supported thereon.

Where it is desired to hydraulically set a liner in a well bore, the housing means 37a may be connected with the lower first connection means 69 to intersect the longitudinal passage therethrough.

Fig. 2A is an enlargement of the housing means 37a and its relationship to the longitudinal passage extending through either the lower first connection means 70 when the Fig. 2 form is employed, or where only the upper first and second connection means 60 and 64 is employed as illustrated in Fig. 1. The housing 37a is mounted to communicate with the passage 61' as illustrated in Fig. 1 where the upper and lower first connection means are employed, and the housing 37a communicates with the longitudinal passage 61' through the lower first connection means as shown in Fig. 2.

An additional lateral passage 43c is provided in the inner tubular member for receiving the housing 37a therein. The housing is provided with a passageway 37b having a seat 37c which may be formed by a split ring 38. A ball or barrier 37 is positoned in the housing 37a on the seat 37c as shown and is engaged with the plunger 39 sealably positoned and threadedly engaged in the housing 37a and movable longitudinally thereof by rotating the member 39a. When the stem 39 is moved longitudinally inwardly of the housing against the ball 37, the split ring 37c is separated to enable the ball 37 to be discharged in-

to the passage 37b for movement into the well string 16 to accommodate hanging the liner by hydraulic pressure in the well string in a manner well known in the art.

The foregoing arrangement enables circulation of well bore fluids through the top drive unit 12, manifold arrangement MA and into the well string 16 beneath the manifold arrangement after the pump down plug means has been positioned in the first connection means. More particularly, when a single pump down plug means is to be employed in a cementing operation, the manifold arrangement illustrated in Fig. 4 and in Fig. 1 will be employed. The ball valve means 61 is closed by inserting a suitable mechanism in the noncircular opening 62c and rotating the ball valve to closed position in a well known manner. The pump down plug means may be positioned in the manifold arrangement before the first connection means are threadedly engaged with feeder 13 and well string 16, and is received on top of the closed valve means 61 as schematically illustrated at 90 in Fig. 2. Further, the valve means 67 in the second connection means associated with the first connection means of the Fig. 4 form is opened so that well bore fluids may be circulated from the drilling fluid line 20 through the swivel 24, top drive unit 12 through feeder 13 and into the upper end of the first connection means. It then bypasses around closed valve 61 through the open valve means 67 to the well string 16 therebeneath so that the fluid in the well bore may be conditioned before cementing operations are begun. If desired, the well string 16 may be rotated and reciprocated while such fluid conditioning occurs, by raising and lowering the top drive unit and also effecting rotation thereof at the same time.

When it is desired to conduct cementing operations in the well bore, cement may be discharged through the conduit 30, the feeder 13 and into the upper end of the longitudinal passage 61' of the first connection means 60. The valve 67 is closed, and valve means 61 opened so that the cement discharges downwardly against the pump down plug means and moves it down through the first connection means and well string as the cement is pumped through the manifold arrangement and into the well string.

Similarly, when the manifold arrangement includes upper and lower first connection means and upper and lower spaced second connection

means as diagrammatically illustrated in Fig. 2, the same operation may be performed. The ball valve means 61 and 62a are closed so that a pump down plug 91 can be first positioned on the lower valve means 62a after it has been closed, and an upper pump down plug 90 may be positioned on the valve means 61 after it has been closed. The valve means 67 in each the upper and lower spaced second connection means is opened and the well bore conditioned by circulating well bore fluid through the top drive unit 12, the feeder 13, and then through the upper and lower longitudinally spaced second connection means 64 and 69 to bypass the closed valve means 61 and 62a and pump down plug means supported thereon to be discharged from the well string to condition the well bore.

After the conditioning of the well bore fluids has been accomplished along with any desired rotation and reciprocation of the well string, cement may then be discharged through the inlet conduit 30 to feeder 13.

A dual plug system is employed as illustrated in Fig. 2 when it is desired to have a pump down plug means at the front end of the cement slurry and a pump down plug means at the end of the cement slurry to separate the well bore fluids from the slug of cement to prevent contamination thereof. Accordingly, in this situation the valve 67 of the lower second connection means 69 is closed while the valve 67 of the upper second connections means remains open. Also valve 61 in first connection means 60 is closed, and valve 62a is opened. This permits the cement to bypass through upper first connection means 60 and around the upper plug means 90 supported on the closed valve means 61 and discharge into the longitudinal passage of the lower first connection means for moving the lower pump down plug means 91 through the open valve means 62a (which has been opened) in the lower second connection means and into the well bore string 16 ahead of the cement.

After the desired quantity of cement has been discharged into the feeder mechanism 13, the valve means 67 in the upper second connection means 64 is closed and valve means 61 is opened so that when cement is discharged into longitudinal passage 61a of the upper first connection means it moves the upper pump down plug means 90 through the open

valve means 61 and then into the well string 16 in the well bore behind the cement.

If desired, the well string may be reciprocated and rotated while the cementing operations are being conducted.

When well bore fluids are circulated to condition the well before cementing operations, the valves 61, 62a in upper and lower first connection means 60 and 70, respectively, are closed and valve means 67 in upper and lower spaced connection means 60 and 70 are opened for flowing the well fluids around the plug means 90 and 91 supported on the closed valves 61 and 62a of the first connection means.

The foregoing manifold arrangement allows a direct line of communication for fluid flow through the top drive power unit 12 to and into the longitudinal passage of the manifold arrangement for accomplishing well bore conditioning operations either before and/or after the cement plug means employed in the cementing operation have been positioned in the manifold arrangement. Further, such arrangement is simple and eliminates some of the valving arrangement required with prior art structures. It also permits the well bore to be conditioned by circulating fluids from the inlet 20, through the top drive unit 12 and through the manifold assembly with the cement plug means in place and ready to be activated by cement supplied through the separate inlet 30. This enables the well bore fluid to be more readily conditioned independently of the cement supply inlet. Also, it enables the cement to be more readily supplied independently of the well fluid circulation inlet.

The foregoing disclosure and description of the invention are illustrative and explanatory thereof, and various changes in size, shape and materials as well as in the details of the illustrated construction may be made without departing from the spirit of the invention.

CLAIMS

1. A manifold arrangement for connecting between the hollow, rotatable stem extending through a top drive power unit and a well string for conducting fluid circulation and cementing operations employing cementing pump down plug means comprising:

assembly means for conducting a pumpable substance such as cement to the well string without first conducting it through the top drive power unit rotatable stem, said assembly including:

an outer tubuluar member; a rotatable inner tubular member with a longitudinal passage therethrough;

said rotatable inner tubular member and longitudinal passage therethrough extending through said outer tubular member;

said rotatable inner tubular member having connection means connectable with the hollow stem for communicating the longitudinal passage in said inner tubular member with the hollow stem beneath the top drive power unit and with the well string;

said outer tubular member having lateral flow passage means to communicate with the longitudinal passage extending through said inner tubular member;

said rotatable inner tubular member having a circumferential groove on its outer surface intersecting said lateral flow passage means and said outer tubular member having a mating circumferential groove formed on its inner surface which groove means cooperate to form a continuous fluid flow passage in each said inner and outer tubular members communicating with said lateral passage means;

bearing means to accommodate rotation of said inner tubular member by the top drive power unit

relative to said outer tubular member; and

seal means between said rotatable inner tubular member and outer tubular member on each side of said lateral flow passage means;

first upper connection means having a longitudinal passage extending therethrough with an open upper end connected with the top drive power unit rotatable stem for communicating the rotatable stem of the top drive power unit longitudinally into and through said first upper connection means;

first lower connection means having a longitudinal passage extending therethrough with an open upper end connected with the lower end of said first upper connection means;

a valve intersecting the longitudinal passage in said first upper connection means and a valve intersecting the longitudinal passage in said first lower connection means;

second upper connection means having passage means therethrough connected with said first upper connection means at a point above and below said valve in said first upper connection means for bypassing fluid flow from the top drive power unit around said valve when it is closed with a cement plug means supported therein;

second lower connection means having passage means therethrough connected with said first lower connection means to intersect the longitudinal passage in said first lower connection means at a point above and below said valve in said first lower connection means for bypassing fluid flow from the top drive unit around said first valve when it is closed with a cement plug means supported therein;

a valve in the passage means formed by said second upper connection means which when in open

position accommodates fluid flow around said closed valve in said first upper connection means with the cementing plug means supported thereon and when in closed position closes flow through said second upper connection means to thereby direct flow longitudinally into said first upper connection means for propelling the cementing plug means through said open valve in said first upper connection means and into the well string; and

a valve in the passage means formed by said second lower connection means which when in open position accommodates fluid flow around said closed valve in said first lower connection means with the cementing plug means supported thereon and when in closed position closes flow through said second lower connection means to thereby direct flow into said first lower connection means for propelling the cementing plug means through said open valve in said first lower connection means and into the well string.

2. The manifold arrangement of claim 1 including:

housing means;

means for connecting said housing means to said rotatable inner tubular member to communicate with the longitudinal passage therethrough;

ball means supported in said housing; and

means to accommodate movement of said ball means from said housing means into the longitudinal passage of said inner rotatable tubular member.

3. A manifold arrangement for connecting between the hollow rotatable stem extending through a top drive power unit and a well string for conducting fluid circulation and cementing operations, substantially as described with reference to the accompanying drawings.

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